

CONTROL OF "CHOICE" BY APPLICATION OF THE
ELECTROMAGNETIC FIELD EQUIVALENTS OF SPOKEN
WORDS: MEDIATION BY EMOTIONAL MEANING
RATHER THAN LINGUISTIC DIMENSIONS?¹

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Summary.—Electromagnetic equivalents (about 1 microT) of the acoustic signature of spoken words were applied across the temporoparietal lobes by an array of external solenoids. Participants were asked to select the target word within a group of words. The experimental group of 7 chose the target word or words that shared its emotional dimensions (activation, evaluation) more frequently than did the reference group of 6 who received no electromagnetic equivalents. Implications for the neurocognitive detection of the emotional (connotative) components of word stimuli when transformed to electromagnetic equivalents rather than direct images or "word sounds" are discussed.

Weak electromagnetic fields whose temporal structures contain meaningful neuronal information have been shown to affect the themes of subjective experiences, declarative memory (Richards, Persinger, & Koren, 1996), and the intensity of postexposure suggestibility (Tiller & Persinger, 1994) when the signals are applied across the temporoparietal lobes by an external array of solenoids. More complex arrays, employing even lower intensity fields (picoTesla) have been shown to influence positively clinical patients who display neurological disorders that can be characterized by persistent anomalous neuroelectrical patterns within the brain (Sandyk, 1992, 1995). These experiments have strongly suggested that the temporal structure of weak, externally applied electromagnetic fields contains neurally relevant information that can alter the specific neural correlates associated with both covert (subjective experiences) and overt (psychomotor) responses.

Since Frey's critical discovery (1961) that radio frequency energy (pulsed within the extremely low frequency range) can induce specific although nonlinguistic auditory experiences, the possibility that electromagnetic fields applied from distant sources can induce linguistic experiences such as "thoughts" or verbal instructions has been considered. The concept that linguistic experiences, such as thoughts or "hearing verbal instructions" could be induced directly within the temporoparietal cortices by electromag-

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netic fields without transduction of mechanical (auditory) energy into digital axonal impulses is compatible with Mueller's nineteenth century Doctrine of Specific Nerve Energies. It states that at any given time we are only aware of the states of our nerves. If the sequences generated within the brain by normal sensory transduction were simulated by direct application, then the correlative experience would be just as real.

The possibility of directly transmitting semantic information into the brain by translating the spectral pattern of the pronunciation of a word into its electromagnetic equivalents would appear to dictate an isomorphism between the acoustic stimulus and the neurocode associated with that specific phonological experience. Although direct experimental evidence for this relationship has been ambiguous, the anecdotal cases of "hearing" (without a radio) the content of programs generated by radio broadcasts would be consistent with, at least in some individuals, this type of isomorphism (Persinger & Lafreniere, 1977).

Words, however, have two major dimensions that in general are subserved by cognitive processes within the left and right temporoparietal cortices (Persinger, 1993; Persinger & Makarec, 1991). The categorical dimension is defined by the perceptual features of experiences and has been hypothesized to be arranged within the lexicon according to a hierarchy of these shared perceptual characteristics. Consequently the words "bear" and "wolf" would share more adjacent positions within semantic or lexical space than would the words "doorway" and "chair."

The second dimension of linguistic experience involves the emotional meaning of the word. Whissell and her colleagues (Whissell, Povey, & Dewson, 1987; Whissell, 1989) have shown that words display two strong orthogonal emotional dimensions of evaluation and activity. Words can be mapped upon a two-dimensional axis of unpleasant-pleasant and low activity-high activity. Within the emotional or affective domains, which appear to be influenced primarily by classical right-hemispheric features, the similarity of words is determined by their proximity in emotional space. For example, the words "bribing" or "embarrass" compared to "admire" and "thanking" exist in diagonally opposite space within the two-dimensional axis even though each of these couplets do not share any distinctive perceptual or categorical similarity.

The existence of two fundamentally different organizational strategies for linguistic experience within the brain has important implications. First, the occurrence of "two strategies" facilitates understanding of the apparent irrationality of different types (states) of consciousness (most dreams) because the images would share similar emotional characteristics rather than categorical, syntactic, or perceptual features. Secondly, experiences represented in right-hemispheric format would be "stored" as emotional meaning

rather than specific images or words. This concept is particularly important for the reconstruction of experiences, primarily episodic memory, and predicts that, although the emotional tone of a "memory" can be valid, the perceptual details and images could be invalid. In a clinical setting, for example, the adult patient's autobiographical reconstruction of the occurrence and the cause of an ontogenetically earlier aversive event (such as an injured left arm or left leg) might be attributed to a different source (such as the imagery associated with a person) if that source shared the emotional dimensions of the original experience (Whissell, *et al.*, 1987; Persinger, 1994, 1996).

The third implication of the existence of two linguistic domains (categorical vs emotional meaning) is that different transform functions between neuroelectrical (and hence neurocognitive) electromagnetic sequences might exist. A more direct isomorphism between the pattern of the electromagnetic field and its meaningful representation within the neural nets of the brain could exist. We designed an experiment that would test the possibility that the "choice" of words could be influenced, without the knowledge of the participant, by applying the electromagnetic equivalent of spoken words. We predicted that this complex field would affect the neurocognitive processes which mediate the affective dimensions (evaluation; activation) or the "feeling" of words. Consequently, the application of the electromagnetic signature of the word through the temporoparietal lobes should influence the person's choice of words that share emotional similarities to the target word as well as the target word itself.

METHOD

Subjects

A total of 13 participants volunteered for this experiment. There were 6 men and 7 women whose ages ranged from 20 years to 25 years. The participants were first-year university students who received a two-point bonus for a course grade.

Procedure

A total of five words were selected for each of 12 trials. The single target words for the trials (12 words in total) had been clearly spoken into a microphone (Realistic Model 33-986B) and digitized with an ATI stereo fx sound card in an IBM PS1 486 SX 25 MHz computer at a sampling rate of 11025 Hz (91 microsec.) that was used by Windows 3.1 sound recorder. The playback sampling rate during the experiment was 11500 Hz (87 microsec.).

The presentation of each individual target word employed a DOS call-to-utility program Scopetrax (C. S. Craig copyright, 1992 Freeware) through

a custom interface programmed in Turbo-Pascal (Version 5.5, copyright Borland International, 1983, 1989). The Scopetrax program transformed each standard wave format sound file (MS Windows 3.1 RIFF-wav format) to the parallel port of a Zenith 286 AT computer (Model ZCV-2525-EY) which in turn drove an 8-bit digital-to-analogue converter (DAC). The output voltage from the DAC corresponded to the 8-bit (0 to 255) range with ± 6 Volt output. Consequently -6 V was equal to 0, 0 V was equal to 128 and $+6$ V was equal to the maximum value of 255. The DAC output was then directed to a solenoid array producing time-varying magnetic fields through the temporoparietal regions of the subject's head. Earphones, connected to the DAC allowed verification that the signal (word) was presented.

Each of the 12 target words was presented 20 times with a 2000-msec. pause between presentations. The 12 words were selected from the extremes of the four quadrants of Whissell's dimensions of evaluation and activation. These quadrants were low evaluation and low activation, low evaluation and high activation, high evaluation and low activation, and high evaluation and high activation. There were three words per quadrant. Each target word was one of five words printed on a single 8- $\times$ 11-in. page. There were different words on each of the 12 pages, i.e., 60 words. On each page two of the four nontarget words had been selected from the orthogonally opposite quadrant. For example, if the target involved the low evaluation and low activity quadrant, the two contrast words were from the high evaluation, high activation quadrant. The other two words shared one of the two dimensions with the target word. There was a blank page between word sheets to prevent perception of the sequence of stimuli.

Each subject was tested singly. Each participant sat within a comfortable chair housed within an acoustic chamber. Each person wore a modified motorcycle helmet. A cluster of four solenoids had been embedded within the helmet along each of the two temporal planes (Richards, Persinger, & Koren, 1993). The chamber lights remained operative so that the participants could read. They were given the booklet that contained the 12 lists of words and told not to proceed. The participants were instructed to "feel" the word that was appropriate when instructed and not to guess quickly.

The experimental sequence was controlled by computer and was the same for all participants. Each trial (list of five words) was 2 min. in duration. Each trial began with an instruction by the experimenter (delivered by chamber speakers) to "turn the page and to feel the word now" for the subsequent 100 sec. At the end of this duration they were instructed to "choose the word." Ten seconds later they were asked to turn the page to the next list of words (trial) and to "feel the word."

During the 80 sec., the electromagnetic equivalent of the word was presented once every 2 sec.; the commutators, which shifted the active sole-

noids of the four pairs of solenoids (spatial rotation), completed one cycle every 20 sec. (5 sec./pair of solenoids). The presence of the field was verified by a Metex 3800 multimeter and magnetic sensor probe (Electric Field Measurements: EFM 140-3-60-1499 milligauss probe); the typical field strength was about 1 microTesla (10 mG). The fidelity of the wave was verified by placing an identical solenoid connected to an amplified speaker 10 cm from the array of solenoids. Induction from the magnetic equivalent of the word was sufficient to induce an acoustic transduced pattern that was quite discriminable (although more "metallic") during casual listening.

Six of the subjects (3 men; 3 women) received the sham field while the remaining seven (3 men; 4 women) received the magnetic field presentations. This sample size was selected *a priori* since we considered any practical effect must accommodate at least 25% of the variance. A statistically significant group difference ($p < .05$) for this sample would require an eta value (correlation coefficient) greater than .50.

Two hypotheses were tested: (1) the subjects who received the electromagnetic equivalents of the word would select the target word more frequently than the subjects who served as sham field controls and (2) the subjects who received the electromagnetic equivalents of the word would select the target word plus the two words within the list that shared at least one of the two emotional dimensions as the target word. All analysis involved SPSS software on a Vax 4000 computer.

RESULTS

The mean and standard deviation for the accuracy of target words for the group who received the electromagnetic equivalents of the word were 0.20 and 0.08, respectively, while these values for the reference group were 0.21 and 0.10, respectively. One-way analysis of variance indicated no statistically significant difference ($F_{1,11} < 1.00$, $p > .05$) between the two groups. Consequently, the first hypothesis that the specific word would be transmitted more accurately was not supported.

Relative to the reference group, however, the subjects who were given the electromagnetic equivalents selected the target word or the words that shared at least one emotional dimension with the target word significantly more frequently ($F_{1,11} = 5.87$, $p < .05$; $\eta^2 = 35\%$) than the two words whose emotional dimensions were completely opposite to the target word relative to the reference group. The means and standard deviations for this proportion of choices for group who received the electromagnetic equivalents of the word were 64% and 6% while these values for the reference group were 54% and 8%, respectively.

To discern whether the electromagnetic equivalent from words from any particular quadrant of the Whissell dimensions was responsible for the

main effect, a two-way analysis of variance with one level repeated (emotional quadrant of the word) and one not repeated (no field, field) was completed. The main effect between treatments was confirmed ($F_{1,11}=5.87$, $p<.05$; $\eta^2=35\%$). There were, however, no statistically significant differences in choice among the words from the four quadrants ($F_{3,33}=0.74$, $p>.05$), and there was no statistically significant interaction between field condition and emotional quadrant from which the words were taken ($F_{3,33}=0.44$, $p>.05$).

DISCUSSION

The results of this experiment did not support the hypothesis that a person's selection of words can be affected by the application of the electromagnetic fields whose signature simulates the acoustic components of that word. The results of this experiment, however, suggested that the application of the electromagnetic equivalents of a word affect the selection of words that share emotional meaning with the target words.

The possibility that the effect was artifactual is minimal. Were the participants "hearing" the specific word or were its representations occurring within neurocognitive modules below the level of "awareness," a specific effect would have been noted with the target words only. Instead, the participants who received the fields were more likely to select words which shared either the evaluative or activation dimensions. Because these words were phonetically different and categorically unrelated, the likelihood of "subliminal" phonetic or lexical decoding appears minimal.

One interpretation of these results is that the electromagnetic equivalents of acoustic patterns, e.g., words, may affect a person's behaviour through the emotional dimensions of linguistic processing. The emotional dimensions of words primarily affect the person's responses (which include feelings, opinions, or attitudes) towards the corresponding stimulus without correlative awareness or verbal imagery. Although the person can generate attributions to the cause of their feelings, impressions, or opinions, these "logical" or verbal explanations are frequently *ad hoc* rationalizations and are also frequently inaccurate.

We have hypothesized that the affective dimensions of words involve the neurocognitive processes that emphasize traditional right-hemispheric functions within most people. These experiences are (1) strongly emotional, (2) relatively inaccurate with respect to categorical detail or imagery, (3) quickly evoked, and (4) affect behavior without being represented into the left-hemispheric equivalents of "awareness" (Persinger, 1993). The latter occurs because conscious awareness concerning the sense of self and the recognition of changes during introspection are strongly dependent upon linguistic processes typically associated with the left hemisphere.

Frey's original work involved the propagation of symmetrical, redun-

dant pulses carried by microwaves. Peripheral effects upon the physiological transducers of acoustic energy to the digital sequences of brain language were considered the most likely explanation. The present results indicate that complex information carried as electromagnetic patterns into the brain may not affect "hearing" experiences but can affect a person's choice without corresponding experiences that are attributed to "thinking" or "decision." Whether the information can be coded upon microwave carriers and propagated through space to influence large populations must still be discerned (Persinger, 1995).

In extending these notions, one may speculate that such influence would not require technology that must first induce detailed information or imagery within the average brain. Instead, simple classical conditioning paradigms could be applied. For example, the presentation of specific images concerning a target stimulus (a national group, person, or event) through conventional modalities (such as television) would be paired, particularly during local night when right-hemispheric processes are intermittently enhanced, with an electromagnetic word-equivalent that evokes negative, affective experiences. The temporal contiguity between the specific image of the target stimulus and the unpleasant affect evoked by the electromagnetic pattern would increase the likelihood that the "feeling" or "emotional meaning" about the target stimulus would be more aversive. Within large populations such general but weak effects could shift the direction of group decisions.

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